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REPORT

OF THE

SUPERINTENDENT

OF THE

UNITED STATES NAVAL OBSERVATORY

FOR THE

FISCAL YEAR ENDING JUNE 30, 1901.

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United States Naval Observatory,
Washington, D. C., August 26, 1901.

Sir: I have the honor to submit the annual report of the operations of the United States Naval Observatory for the fiscal year ending June 30, 1901.

THE 26-INCH EQUATORIAL.

This instrument has been in charge of Prof. T. J. J. See during the whole year. Owing to the death of Mr. George Anderson, who had been assistant on this instrument for twenty-six years, which occurred in November last, and to the absence after February 1 of the party sent out by the Observatory to observe the eclipse of the Sun in Sumatra, Professor See worked entirely alone for a part of the year. The manual labor alone in using this instrument is considerable, and I consider the showing made in Professor See's report as creditable. This instrument has been devoted to the same general line of work as in previous years, and has been maintained in good order. Professor See's report is herewith transmitted.

THE 9-INCH TRANSIT CIRCLE.

This instrument has been steadily employed on the regular sun, moon, and planet work, a revision of the Astronomische Gesellschaft Zones, and the Zone of Zodiacal Stars undertaken for the Paris Astronomical Conference of 1896. From long service this instrument is in need of important repairs. The pivots have become so worn as to need regrinding, and the illumination should be changed so that the reticule will be illuminated by a beam of light in the optical axis of the instrument, instead of a beam cast from one side, as at present. As soon as the alterations of the 6-inch transit circle, which are noted later, are completed, the whole staff for meridian observations will be transferred to that instrument, and the 9-inch transit circle will be put under repairs. The report of Assistant Astronomer King, in charge of the instrument at the close of the fiscal year, is transmitted herewith.

THE 6-INCH TRANSIT CIRCLE.

Since this instrument was mounted two years ago a serious defect in the form of a diurnal change in the constant of azimuth, following changes of temperature, has been a source of annoyance and embarrassment and a serious detriment to the usefulness of the instrument. Since March last a systematic and patient investigation of this defect has been carried on by Professor Updegraff with the object of determining, and if possible removing, the cause. Successive changes have been made in the instrument and its supports as a result of this investigation, without in any way altering its form (which could not be done without entirely rebuilding it), and there is reason to believe that the success of these changes is already assured.

This instrument was built by Messrs. Warner & Swasey, of Cleveland, Ohio, from designs by Prof. William Harkness, U. S. N., following closely the pattern of the latest instruments by Repsold, of Hamburg. It would be presumptuous to criticise the result of the experience of the oldest and most skillful instrument makers in the world, and yet I can not believe that this form of instrument will ever be entirely free from uncertainty in the errors of azimuth or level, or both, for the reason that in order to assure precision in other respects a principle has been sacrificed which has been recognized as fundamental in the construction of astronomical instruments for at least two hundred years, viz, that the instrument itself should be directly supported on a substantial foundation of masonry. In this form of instrument the pivots are supported by a skeleton work of metal by which they are raised sixteen inches above the piers. Differences in the rate of expansion between the masonry of the piers and the metal supports of the pivots become immediately apparent in the azimuth or level of the instrument, and some evidence of this will, I believe, be always apparent. If these errors can be reduced to something manageable under normal conditions, there will still remain the probability that abnormal conditions and sudden and excessive changes of temperature may still make them inconveniently apparent. In this connection I may observe that preparations have been made for a south meridian mark for both the 6-inch and 9-inch meridian circles, but no steps have been taken during the year to erect them.

THE CLOCK SYSTEM.

The effort to bring the department of meridian observations, which is the real *raison d'être* of the Observatory itself, to a state of the highest efficiency and up to the most modern standard of requirement, has included not only a thorough overhauling of both meridian instruments, but also an examination, and if possible an improvement, in the clock system of the Observatory. Critics who are in no way responsible for results, and who probably would not carry out their own suggestions if they were, have had a standing grievance against the Observatory because it has not put its clocks underground. In point of fact very few observatories do put their clocks underground. The notable exception is Pulkowa. It is difficult to maintain a clock underground and not ruin it by rust. The experiment was tried in the very early days of the Naval Observatory and abandoned after the valuable Kessels clock had been nearly sacrificed to the experiment. If, however, a clock can be inclosed in air-tight case from which the air has been partially exhausted, it should be entirely removed from the influences of temperature, pressure, and humidity, and it should, theoretically, be as safe in a vault as above ground. This is the principle which has governed the construction of the clock vault of the Naval Observatory. The vault is dug in the basement of the clock house, which stands on the highest eminence in the Observatory grounds, a knoll of quite abrupt grades, of a gravel soil, and so situated that the natural drainage is away from the vault in all directions. The vault is built with double walls and roof and thick concrete floor, the space between the walls being filled with nonconducting material. The air of the vault is dried by gas and proper provision is made for ventilation. The air-tight cases containing the clocks are of metal and glass, and in each is exposed in full view a rust gauge of bright steel, which is closely watched, and its condition reported to the Superintendent at frequent intervals. The Kessels clock, which is regarded as the standard, is regulated to mean time, and as it is not capable of sustaining the electrical connections necessary for chronometric connection on the clock circuit, it is compared with the sidereal sounder by coincidence of beats by the aid of a microphone, the beats of the clock being wholly inaudible to the unaided ear. So far the whole arrangement has proved on the whole satisfactory, and the rate of the Kessels clock reduced to a constant of almost zero. Some trouble has been experienced in making the clock case actually air-tight, and if the experiment (for I regard it as no more than an experiment) fails, it will be from this cause. Professor Updegraff's report is herewith transmitted.

THE 12-INCH EQUATORIAL.

This instrument has undergone extensive alterations during the year. It was remounted in April, and has been employed, in charge of Assistant Astronomer Theo I. King, since that time. This instrument is used for the benefit of visitors admitted to the Observatory at night.

THE PRIME VERTICAL TRANSIT INSTRUMENT AND THE 5-INCH ALT-AZIMUTH.

These instruments have remained in charge of Assistant Astronomer G. A. Hill, in continuation of the observations for variation of latitude.

I invite the attention of the Bureau to Mr. Hill's report, as evidence of the spirit in which the Observatory has been (and still is) criticised by outside astronomers. Malice has dictated these criticisms, to my knowledge, for thirty years. In this instance ignorance becomes a valuable accessory.

THE 40-FOOT PHOTOHELIOGRAPH.

Photographs have been taken of the sun daily whenever the weather and other circumstances would permit. During the absence of the photographer, Mr. George H. Peters, on duty with the eclipse expedition, his place was supplied by Mr. E. A. Boeger, Computer.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

By virtue of a provision of the urgency deficiency bill of the last session of Congress, the Observatory was enabled to equip and put in the field an expedition to the island of Sumatra to observe the total eclipse of the sun of May 18, under charge of Prof. A. N. Skinner, U. S. N. Professor Skinner's very interesting preliminary report of the expedition and its results is forwarded herewith. A detailed report will appear in conjunction with a report of the eclipse of May 28, 1900, in a forthcoming volume.

It may very reasonably be asked whether, in view of the meager results on account of cloudy weather on the day of the eclipse, the expense of sending an expedition to such a distance was a justifiable outlay of public money. The reply would be that a chance of failure on account of the weather was one of the conditions which attached unavoidably to the undertaking. Other expeditions were less fortunate and secured no results at all. But the real answer is that results no matter how meager, fully justify the outlay, because such results are not to be judged by themselves, but are to be regarded as forming a part of the general sum of observations of this and other eclipses. The problems presented will be solved, not by the recorded observations of any one person at any one time, but by the accumulation of such observations in the general account of human knowledge. From this point of view even one photograph, or a single observation of contact, would have fully justified the entire outlay. At Fort de Kock ten excellent negatives were obtained, which were acknowledged by foreign astronomers to be the best made by any party in the field, and at Solok, the Observatory's other station, contacts were observed and some photographs obtained. I am satisfied with the results.

A serious drawback to the expedition has been the withdrawal for so long a period of an important part of the Observatory's astronomical staff.

An acknowledgement is due the War Department for uniform courtesy to the expedition both on board the transports and at Manila, and to the commanding officer of the U. S. S. *General Alava* for much valuable assistance.

COMPUTATIONS AND PUBLICATIONS.

Since my last report the whole computing force of the Observatory has been assembled in one bureau, instead of being distributed to the various instruments as heretofore. This change has resulted in a decided economy of time and labor, and is generally in the interests of system and efficiency. All astronomical observations, by whomsoever made, are turned over to the computing bureau for reduction, it being understood that the author is consulted as to the methods of reduction and exercises a general supervision in cooperation with the officers at the head of the bureau. Professor Eichelberger has been placed in charge of this bureau, and in his absence with the Sumatra eclipse expedition his place was supplied by Assistant Astronomer King, up to the close of the fiscal year.

During the year the first volume of the new series of Washington Observations has been published and distributed. The second volume is ready for the press and will be printed immediately. A third volume is nearly ready, and other volumes will follow as rapidly as the material can be prepared for the printer, and until the accumulation of unpublished work is exhausted. This breaks the long suspension of printing which has been a source of anxiety for several years. Leniency in criticism of the quality of the work thus issued is not asked nor expected. Scientific work must stand or fail on its merits. But it would be an encouragement, little to be expected, if the scientific world of this country could appreciate or acknowledge the efforts to bring up to date work long in arrears. Appreciation from abroad is not wanting, and has been gratefully acknowledged.

THE NAUTICAL ALMANAC OFFICE.

Prof. W. S. Harshman was appointed Director of the Nautical Almanac March 28, 1901. Up to that time and since the retirement of Prof. Simon Newcomb the direction had been in the hands of a professor of mathematics who held the post in addition to his regular duties at the Observatory. The Almanac demands the undivided time and attention of a competent director. This need had become imperative. Professor Harshman has had the advantage of long experience in the office in a subordinate capacity. He has systematized and regulated the office and brought the work up to date, the regular issue of the Almanac three years in advance having failed. The office is now in a high state of efficiency, and general harmony and enthusiasm prevail in its staff. The Nautical Almanac Office has been noted, since its foundation in 1849, for thoroughness and precision in its methods and for superior excellence in its personnel. That this quality is still dominant is shown by the high stand taken by several of its staff in the competitive examinations for professorships. The report of the Director of the Nautical Almanac is herewith transmitted.

THE RECEPTION OF THE PUBLIC DURING THE WORKING HOURS OF THE NIGHT.

During the year there were issued to the general public 765 regular admission cards by this office, and about the same number by the Bureau of Equipment. These cards admit visitors, holding them, to the Observatory during working hours on one night each week. It has been necessary to adopt a rigid system in the admission of visitors, and to limit the number admitted at any one time to the capacity of the dome. The result has been that cards are sometimes issued months in advance of the date for which they are good, for the whole number of persons making application is so far above the capacity of the Observatory that if all were immediately gratified the institution would be completely given up to this and nothing else. Besides the regular cards as above specified special arrangements have been frequently made for Senators, members of Congress, persons in official life, and visiting astronomers; about nine classes in astronomy from various schools, composing fifteen or twenty young persons each, with their teachers, have also been specially accommodated. Some time since I recommended that the admission of the public during working hours at night be wholly suspended. The numbers seeking admission seem to be constantly increasing. I believe that the Naval Observatory is the only observatory in the world, except a few which have been founded and are conducted avowedly for popular purposes, at which this practice exists. In every department of the Government the public is excluded from certain sections and offices in which its presence would be detrimental to the public interests. The Naval Observatory stands as an exception to this rule. But it is only of late years that this practice has prevailed at the Observatory. I am familiar with the conditions which led to the abrogation of a rule which had been rigid from the foundation of the Observatory, and I can say that the purpose then in view was not in the slightest degree subserved by this concession to public curiosity.

The work of the Observatory is so purely technical in character that it can be said, without in the least impugning either the motives or the intelligence of the visiting public, that to no one not versed in practical astronomy would any detailed explanation of the methods of that work be either interesting or intelligible. Consequently, popular subjects must be sought for the gratification of visitors. These are the objections to the practice of admitting visitors during working hours. On the other hand, I can not say that the presence of visitors on one evening a week is a serious interference with the work of the Observatory. Visitors are never admitted to the transit rooms. The 12-inch equatorial is withdrawn from its regular assignment for a few hours in the early evening once a week. If there were but one equatorial telescope at the Observatory this might be a serious interference. As it is, provision for visitors can be made without serious interruption of necessary or emergency work.

I am of the opinion that the concession never should have been made in the first instance. But the practice once established, under proper restrictions, it becomes a delicate and invidious matter to recommend its total suspension, the more so as almost without exception in the experience of the Observatory the appreciation of the privilege on the part of those who have enjoyed it is very marked.

THE BOARD OF VISITORS.

The Board of Visitors established by the naval appropriation act approved March 3, 1901, which went into effect on July 1, met in April, and since that time and prior to July 1, two duly constituted committees of the board have visited the Observatory officially. The law provides for one "annual visitation to the Observatory at a date to be determined by the Secretary of the Navy, and * * * such other visitations, not exceeding two in number annually, by the full board or by a duly appointed committee as may be deemed needful or expedient by the majority of the board." The board has already made the full number of visits allowed by law to any one year.

THE DEPARTMENTS OF NAUTICAL INSTRUMENTS, OF GENERAL STOREKEEPER, AND OF CHRONOMETERS AND TIME SERVICE.

By the detachment of Lieut. Commander Charles E. Fox in May, the last remaining officer of these departments was withdrawn, and all of these important departments left without any regularly assigned personnel whatever. The regulations for the government of the Observatory issued by the Department provide for three officers for this work. I believe this situation is unique in the public service. It is hard to make bricks without straw, but that is the situation of these departments at the present time.

As the work could not cease, a computer, previously detailed from the astronomical department, has been put in charge of these departments, with one of the clerks of the Observatory in charge of the books. This arrangement is not only improper, but is prejudicial to the service and injurious to the individual. I have in previous reports made specific recommendations looking to the establishment and maintenance of a permanent force for these departments. I renew these recommendations. The accompanying reports show the volume of business in these departments for the year.

MAGNETISM AND METEOROLOGY.

As noted in my last report, magnetic observations have been discontinued. Meteorological observations are kept up under the same conditions as have prevailed since the establishment of the Observatory.

GROUNDS AND ROADS.

The naval appropriation act carried a fund for the purchase of lands lying within the Observatory Circle not included in the original purchase. Steps have been taken for the immediate acquisition of these lands. I renew my recommendation that none of the outlying tracts be sold at present. Most of this land is wooded, and affords a screen for the Observatory buildings, and until the extension of Massachusetts avenue is completed it would be impossible, I believe, to dispose of this land to advantage. On general principles it is good policy for the United States to hold on to all the land it owns in the District. The grounds are gradually improving, and the buildings are in good order. A house provided for the foreman and captain of the watch by the appropriation of last year has been completed and is occupied. It is a decided advantage in the care of public property and the inter ests of the establishment to have this official resident upon the place.

LIBRARY.

	Volumes.	Pamphlets.	Total.
Contents of the library July 1, 1900	17,600	3,817	21,417
Accessions	425	74	499
Contents July 1, 1901	18,025	3,891	21,916

Of the accessions, 293 were received as exchanges and 206 were purchased. The following publications were distributed in regular exchange:

Report of the Superintendent for 1900.

Astronomical, Magnetic, and Meteorological Observations made during the year 1891.

Astronomical, Magnetic, and Meteorological Observations made during the year 1892.

Publications, U. S. Naval Observatory, 2d series, volume 1, Sun, Moon, Planets, and Miscellaneous Stars, 1894–1899.

PERSONNEL.

The following changes have taken place in the personnel of the Observatory during the fiscal year:

Lieut. Commander Charles E. Fox, U. S. N., reported for duty on November 7, 1900, and was assigned to the Departments of Nautical

Instruments, of General Storekeeper, and of Chronometers and Time Service as the relief of Lieut. Commander B. W. Hodges, U. S. N., who was detached on March 15, 1901.

On May 14, 1901, Lieut. Commander Fox was temporarily detached to attend a course of instruction at the Naval War College, Newport, R. I., and was absent the remainder of the fiscal year.

Prof. S. J. Brown, U. S. N., was detached on March 25, 1901, from the Naval Observatory and as Director of the Nautical Almanac, and Prof. W. S. Harshman, U. S. N., was appointed Director of the Nautical Almanac on March 28, 1901.

In the astronomical department there were eleven miscellaneous computers temporarily appointed during the year. Three of them have received permanent appointments, Miss Clara M. Upton, Miss Eleanor A. Lamson, and Mr. Everett I. Yowell, and two are still serving probationary periods.

Mr. W. W. Dinwiddie was appointed a laborer on September 10, 1900, and promoted on November 9 to skilled laborer to succeed George Anderson, who died on October 21, 1900.

On January 30, 1901, another laborer, Gustave Harrison, was appointed to the vacancy caused by the promotion of Mr. Dinwiddie.

I am, sir, your obedient servant,

C. H. Davis,
Captain, U. S. N., Superintendent of the Naval Observatory.

The Chief of the Bureau of Equipment, Navy Department.

THE 26-INCH EQUATORIAL.

Sir: I have the honor to submit the following report on the work of the 26-inch equatorial:

During the year which has just closed this instrument has been devoted to the same general lines of work as in former years. The machinery of the instrument has been improved by thorough ordering, and by slight readjustment of parts of the driving clock, and in consequence its general performance is more satisfactory than at any time since the removal to the new Observatory. The illumination of the dome and of the micrometer and circles of the instrument has been rearranged, and is now highly satisfactory. The observer may illuminate any part of the instrument, or its accessories, by turning electric switches conveniently placed on the instrument or on the walls. And when total darkness of the dome is required, in the observation of the faintest objects, a covered lamp on the table enables the assistant to see the page of the note book without inconvenience to the observer.

Ever since its installation, the elevating floor, operated by hydraulic rams, had occasioned more or less trouble, from the inability of the control valve to hold it at any elevation to which the observer might set; the resulting instability of the floor, which usually acquired a slow creeping motion, proved a source of much anxiety and embarrassment, especially when the observer worked alone. Accordingly, in September, 1900, a new control valve, of the form used on the elevators in the building of the Navy Department, was substituted; and the elevating floor has since performed with entire satisfaction. This improvement in the operation of the floor was especially important in the observations of Eros.

I. PARALLAX OBSERVATIONS OF EROS.

The observations of Eros for the parallax of the Sun were made in accordance with the plans formulated by the International Committee at Paris, and extended over the period from October 9, 1900, to January 29, 1901.

During this period the planet Eros was observed on every available clear, or partially clear, night; and whenever possible, at both ends of the night. The aim was to furnish material for the deduction of the solar parallax by combining the Washington observations with those supplied by other observatories in both hemispheres, or by employing the principle of the diurnal motion of the Earth during the night, and thus deriving the solar parallax from the Washington observations alone. This latter method would have some advantages, in that the observations would all depend on the same observer with the same instrument; while the former would depend on many observers using instruments of various sizes and kinds, and thus working with apparatus more or less heterogeneous. To enable both methods to be used in the final reduction of the work, the position of Eros, relative to comparison stars, was measured three or four times in the evening, between the instant of darkness and eight o'clock, for combination with the measures taken simultaneously at the leading European observatories; and then again observed in the morning, when west of the meridian about six hours.

Observations of this kind were secured on 61 evenings and on 31 mornings. The total number of complete observations was 255, representing something over 5,000 observations with the micrometer. The general aim of the observer was to secure the highest possible accuracy from a reasonable number of observations advantageously distributed through the night, and on as many nights as possible. Observations in the morning hours were made with considerable difficulty, on account of the increased cloudiness of the latter half of the night. It is believed, however, that the conditions under which the work was done on the whole were favorable.

The Eros work was reduced and ready for the printer on June 25. The prosecution of these very delicate parallax observations necessitated a thorough investigation of all the constants of the instrument. The full discussion of these constants will appear in the introduction to the Eros work. The following summary of the chief results will probably suffice for the present report:

1. The value of a revolution of the micrometer screw was determined from differences of declination of stars in the Pleiades, and in the arc *h* Persei, and by transits of circumpolar stars, and found to be $R=9''.9286\pm0.''0005$. The temperature coefficient appears to be practically insensible.

2. The error of elevation of the polar axis, determined from observations of the declinations of Nautical Almanac stars near the meridian, $\xi=-67''.8\pm1''.0$.

3. And the flexure of the tube, $e=-1''.6\pm0''.5$.

4. The error of the polar axis found from the observation of pairs of standard stars of different declinations near the meridian, $\eta=+110''.0\pm1''.6$.

5. The collimation found from observations on a collimator mounted on the base of the dome of the equatorial and pointed on the Helmet of Liberty Statue on the Dome of the United States Capitol, $c=+117''.7\pm1''.9$.

6. The error of rectangularity in the declination and polar axes, found from observations of standard stars near the meridian, $i_1=+104''.1\pm4''.7$.

7. The arc by which the instrumental pole departs from the celestial pole, $\gamma=129''.3\pm1''.9$; $\vartheta=121^\circ\ 39'$.

8. Flexure of the declination axis, $\varepsilon=+1''.6\pm1''.0$ (assumed).

9. The constant, $i=i_1-\varepsilon\ \sin\ \varphi=+105''.1\pm4''.7$. From observations of circumpolar stars at upper and lower culmination the flexure of the declination axis, ε, appeared to be insensible, and was therefore taken to be equal to the differential flexure of the tube. The values of ξ and η seem to have remained quite constant since the telescope was put in use at the new site in 1894. These errors are somewhat larger than are desirable in the final adjustment of the instrument. A slight readjustment of the polar axis is accordingly in contemplation. The pier is so firm that the orientation of the instrument ought then to be entirely satisfactory.

II. THE DIAMETERS OF THE PLANETS AND SATELLITES.

The observations of the diameters of the planets and satellites noted in the last annual report have been continued.

Venus.—Seventeen determinations of the diameter of this planet were taken in July and August, making, with those secured before June 30, 1900, a total of 32 determinations about the inferior conjunction of July 7, 1900. To obviate as far as possible the effects of irradiation the measurements were made from the points of the cusps. The result of this work, done under what are thought to be extremely favorable conditions and with the color screen, was a diameter of $16''.800\pm0''.022$, in very close agreement with the value deduced by Dr. Auwers from an elaborate discussion of the transits of 1874 and 1882. No markings were seen on the surface of the planet, although the definition on several occasions was perfect.

Jupiter.—Diameters of this planet have been taken on 4 nights, and of the satellites on 10 nights. Prior to June 30, 1900, Jupiter had been measured on 19 nights, and the satellites on 8 nights; accordingly, the number of determinations of diameter during the opposition of 1900 was 23 for Jupiter and 18 for the satellites. Measurements were taken of both equatorial and polar diameters, with a view of finding the dimensions of the spheroid, and also of deducing the true ellipticity of figure, which had remained somewhat uncertain on account of a discordance which developed between the values obtained by observation and those computed by the theory of gravitation from the motion of the perijove of the fifth satellite. For the theoretical oblateness Cohn, in 1896, found a value of 1:15.50; subsequently W. S. Adams, using observations up to 1899, made it 1:15.55.

The micrometer measurements of the 26-inch equatorial on 22 nights make the observed oblateness $1:15.53\pm0.21$.

The equatorial diameter of the planet came out 38″.401 ± 0″.038.

The resulting diameters of the satellites were:

Satellite I, 0″.672 ± 0″.098.
Satellite II, 0″.624 ± 0″.078.
Satellite III, 1″.361 ± 0″.103.
Satellite IV, 1″.277 ± 0″.083.

The diameters of all four of these satellites are still under investigation.

Saturn.—The diameter of this planet was measured on 23 nights. The value of the equatorial diameter deduced from 35 determinations during the opposition of 1900 is 17″.448 ± 0″.025.

The ring system was subjected to careful measurement, with the following results:

External diameter of outer ring, 40″.304 ± 0″.030.
Internal diameter of outer ring, 34″.787 ± 0″.022.
Diameter of the center of Encke's division, 37″.777.
Width of Encke's division, 0″.107.
Total width of the outer ring, 2″.758.
Width of the outer part of the outer ring, 1″.237.
Width of the inner part of the outer ring, 1″.414.
Width of Cassini's division, 0″.418 ± 0″.010.
External diameter of central ring, 33″.951.
Internal diameter of central ring, 25″.952 ± 0″.048.
Width of central ring, 4″.000.
Internal diameter of dusky ring, 20″.582.
Width of dusky ring, 2″.685 ± 0″.033.
Black space between Saturn's globe and dusky ring, 1″.567.
Diameter of the satellite Titan, 0″.487 ± 0″.020.

The width of the dusky ring and the diameters of Titan and Japetus have been measured several times during the opposition of 1901.

Mercury.—Three series of measurements have been secured of the diameter of this difficult planet. The first two were preliminary and made while searching for the best conditions, the last being that finally adopted. One hundred determinations in June, 1901, when Mercury was near its greatest eastern elongation, make the diameter 5″.8993±0″.0080. This presents a considerable departure from Bessel's value of 6″.68, which was deduced from measures with the Königsberg heliometer in the transit of 1832, and is more in accord with determinations made at the Lick Observatory by Barnard and Campbell during the transits of 1891 and 1894.

Mars.—The great distance of Mars at the recent opposition and the unfavorable weather then prevailing rendered it inadvisable to attempt anything more than a preliminary determination of the diameter, which was made by daylight in June, 1901. Sixty-nine determinations of the polar diameter on eight days, when the sun was from one to three hours above the horizon and the seeing practically perfect, lead to the value 9″.222±0″.013. With an oblateness of 1:200 this would give an equatorial diameter of 9″.268. Experiments recently made on the irradiation constant for Mars fix its value at +0″.76. The application of the resulting correction of −0″.76 would have the effect of diminishing the diameter of Mars, as ordinarily observed at night and reduced to unit distance, by about 0″.38. The diameter of Mars concluded from a careful study of the micrometer measures of many observers working at a distance of about 0.5

and reduced to distance unity is 9″.68. The concluded equatorial diameter of the solid globe of the planet is therefore 9″.30, in substantial agreement with the value found by Professor Campbell at the Lick Observatory in 1894. This value has been used in a new discussion of the mass of Mercury recently made by the method of Prof. G. W. Hill, based on an extension of Laplace's law for the internal density of the earth. The resulting mass of Mercury is $\frac{1}{16122810}$. Most of the masses heretofore assigned this planet have exceeded $\frac{1}{8000000}$; the smallest yet deduced being one found by Prof. G. W. Hill, $\frac{1}{11634200}$. It is perhaps a little remarkable that an observation of the year 1639 by the English observer Horrocks, when used in certain perturbative equations of Leverrier, leads to a mass of only $\frac{1}{17120000}$, which appeared so small that Von Haertdl rejected it altogether. Future investigations must determine whether this ancient observation does not after all afford a good first approximation of the true mass of Mercury, which has remained more uncertain than that of any other primary planet of the solar system.

III. OBSERVATIONS OF THE SATELLITES.

Satellites of Saturn.—A series of micrometer measurements were made during the opposition of 1900 on the four brighter satellites, Titan, Rhea, Dione, and Tethys. The general plan of the observations is similar to that employed by Prof. Hermann Struve in his well-known work at Poulkowa. Titan and Rhea were observed on 59 nights, Dione and Tethys on 49 nights; 38 of the first group of observations fell within the present fiscal year, and 35 of the second group.

On April 16 observations were resumed for the opposition of 1901, and all the satellites searched for on every available clear night. Before June 30, 1901, the following observations had been secured:

Japetus and Titan were measured on 22 nights.
Hyperion and Titan were measured on 11 nights.
Titan and Rhea were measured on 28 nights.
Dione and Tethys were measured on 26 nights.
Tethys and Enceladus were measured on 19 nights.

The reticule of the micrometer has been provided with a system of parallel webs separated by a distance of 624″.65, which makes it possible to refer Japetus at greater elongation directly to Titan in any part of its orbit, by sliding the eyepiece to bring the two objects successively into the field of view. As the driving clock performs very perfectly, and the mounting of the telescope is extremely rigid, it is hoped that this direct measurement will give data for improving our knowledge of the mass of Saturn, as well as for determining the orbits of the satellites. Hyperion has been recognized without great difficulty except when the sky was strongly illuminated by the moon, or very moist, so that the light of the planet was greatly diffused over the field.

Satellites of Uranus.—During the opposition of 1900 Oberon and Titania, the two outer satellites of Uranus, were observed on 35 nights, 16 of which came within the present fiscal year. During the opposition of 1901 observations of these bodies have been made on 23 nights prior to June 30. The two inner satellites, Ariel and Umbriel, also have been successfully measured by using the color screen to reduce the light of the field about the planet, the former on 8 nights, the latter on 9 nights. In view of the fact that these inner satellites, which on the whole are recognized to be the most difficult bodies of the solar system, were found by Professors Newcomb and Hall to be near the limit of the powers of this telescope, when Uranus was much nearer the zenith, this result of the darkening of the background of the sky by the use of the color screen is gratifying. Umbriel is usually somewhat more difficult than Ariel, though in the present position of Uranus both require a very dark field to bring them within the grasp of the observer.

IV. DOUBLE STARS.

On account of the heavy demand upon the observer's energies in other lines, only a limited number of double stars have been measured during the past year. About thirty difficult pairs, drawn mainly from Burnham's lists, have been observed at odd moments when the telescope was not otherwise employed. With the increase of force on the instrument following the assignment of Computer George K. Lawton, June 14, the hope was entertained of utilizing its powers to their full extent. The lamented death of this talented and accomplished young astronomer, July 25, 1901, after a month's service on the instrument, was not only an irreparable loss to the 26-inch equatorial, but in view of his youth, fine training, high promise, and noble character, altogether one of the greatest losses ever sustained by the Observatory at any period of its history. His abilities were of the highest, his performance of duty beyond all praise. As he had only commenced independent observations, after a broad experience in several lines, it will be very difficult to do adequate justice to his memory, either by the publication of the work which he left unfinished or by the conclusion of those researches upon which he had just entered with so much promise and enthusiasm. It should be stated here that the problems arising in connection with the Eros work were treated largely under the supervision of Mr. Lawton, who had immediate charge of these reductions from the first. In connection with the parallax measures of Eros, and as a volunteer labor outside of his official duties, he made a number of observations for improving the orbit of the planet. He also secured a considerable series of observations of comet Brooks, 1900, and was occupied with the computation of a definitive orbit when his labors were interrupted by illness, which soon proved fatal. In the latter part of June he made some observations of Proserpina, which were communicated to Professor Neugebauer, and had entered upon the measurement of double stars.

PERSONNEL.

The personnel of the instrument during the past year has been as follows:

T. J. J. See, Professor of Mathematics, U. S. N., astronomer in charge.

George K. Lawton, Computer, assistant observer, from June 14 to July 25, 1901.

W. W. Dinwiddie, Assistant on the 26-inch equatorial (absent on the eclipse expedition to Sumatra from February 5 to July 26, 1901).

Miss Clara Upton, Miscellaneous Computer, from June 14 to July 1, 1901.

Important volunteer assistance has been rendered by Mr. George H. Peters and Mr. L. G. Hoxton.

Mr. Gustave Harrison has aided in the observations about half of the time covered by Mr. Dinwiddie's absence on the eclipse expedition to Sumatra.

In conclusion it may be said that the general condition of the building and instrument is satisfactory.

The following papers relative to the work of the 26-inch equatorial have appeared during the year:

1. Preliminary Researches on the Diameters of the Planets Neptune and Uranus. (Astronomische Nachrichten, 3665.)
2. Researches on the Diameter of Venus. (Astronomische Nachrichten, 3675,)
3. Researches on the Figure and Dimensions of Jupiter and on the Dimensions of his Satellites. (Astronomische Nachrichten, 3670.)
4. Observations of Titania and Oberon, the two outer Satellites of Uranus. (Astronomische Nachrichten, 3676.)
5. Researches on the Equatorial Diameter of Saturn and on the Dimensions of his System of Rings. (Astronomische Nachrichten, 3686–87.)
6. Observations of the Four Brighter Satellites of Saturn. (Astronomische Nachrichten, 3714.)

Papers on the Diameter of Mercury, the Mass of Mercury, and the Diameter of Mars have been communicated to the Astronomische Nachrichten.

Respectfully,

T. J. J. See,
Professor of Mathematics, U. S. N.,
In charge 26-inch Equatorial.

The Superintendent, Naval Observatory.

THE 9-INCH TRANSIT CIRCLE.

Sir: I have the honor to submit the following report of the work of the 9-inch transit circle during the year ending June 30, 1901. The instrument was under the charge of Professor A. N. Skinner, U. S. N., until February 5, 1901. While he was absent to observe the eclipse of the sun, Professor W. S. Harshman, U. S. N., directed the work from February 7 to March 28, 1901, and Assistant Astronomer Theo I. King after the latter date. The assistants during the year were Professor W. S. Eichelberger, U. S. N., until February 7, 1901; Professor Harshman, from September 6, 1900, to March 28, 1901; Assistant Astronomer King, Computers W. M. Brown and E. A. Boeger throughout the year; Computer G. K. Lawton until December 8, 1900, also from March 11 to June 7, 1901; Computer J. C. Hammond from August 15, 1900, to March 11, 1901, and Mr. E. I. Yowell after June 7, 1901.

The instrument was used with the clamp west until November 12, 1900; since that date the clamp has been east. While the telescope was being reversed the pivots were accurately measured; the suspicion was confirmed that they had become unevenly worn. A careful investigation by means of the mercury and hanging levels and contact lever, extending from October 28 to November 24, was conducted by Professors Skinner and Eichelberger. This defect, which necessarily affects the reduced positions of objects observed, should be remedied at the earliest possible day. At the same time some of the improvements suggested by the Board of Visitors might be made. It is specially desirable that the counterpoise rollers should be renewed, many of the parts of the micrometer replaced, and improvements effected in illuminating the reticule and microscopes.

The regular sun, moon, and planet work was directed by Professor Eichelberger until September 12, 1900; from that date to March 28, 1901, by Professor Harshman, and subsquently by Assistant Astronomer King.

The Astronomische Gesellschaft zones are still incomplete, a number of revision zones having been taken during the year, while two or three more will be needed. These revision zones have been observed by Professor Skinner and Assistant Astronomer King, with the assistance of Assistant Astronomers King and F. B. Littell.

The zone of Zodiacal stars, undertaken for the Paris Astronomical Conference in 1896, was begun in September by Professor Eichelberger, with the help of Computers Lawton and Hammond, but was suspended after the discovery of the unsatisfactory condition of the pivots.

Observations of the planetoid Eros and the primary list of 319 comparison stars desired by the Astrophotographic Conference were made by Assistant Astronomer King, aided by Computers Brown, Boeger, Hammond, and Mr. R. Y. Ferner.

The following summary shows the number of observations of the various objects:

Ephemeris stars	2,462
Sun	130
Moon	153
Mercury	85
Venus	106
Mars	24
Jupiter	15
Saturn	18
Uranus	18
Neptune	11
Nova Persei	9
Screen stars	318
Astronomische Gesellschaft Zone stars	619
Astronomische Gesellschaft Zero stars	201
Zodiacal Zone stars	1,022
Zodiacal Zero stars	191
Eros	33
Eros Zone stars	1,361
Eros Zero stars	434
Total observations	6,310

Very respectfully,
THEO I. KING,
In charge 9-inch Transit Circle.

The SUPERINTENDENT, NAVAL OBSERVATORY.

THE 6-INCH TRANSIT CIRCLE AND THE CLOCK VAULT.

SIR: From the beginning of the year until February 5 I was assisted by Assistant Astronomer F. B. Littell, who was then temporarily detached for duty in connection with the observation of the total solar eclipse of May 18, 1901. Computer George K. Lawton assisted as microscope reader and recorder from December 8, 1900, to March 7, 1901. Computer J. C. Hammond was detailed on June 7 for duty on the instrument, and has since that time been engaged in the reduction of the observations of the comparison stars for the Planet Eros.

ASTRONOMICAL WORK.

The instrument has been in use on almost every clear night during five and a half months of the year in observing the fixed stars. During the remaining six and a half months repairs and special investigations for the removal of defects have been in progress.

The observations of 135 Comparison Stars for the planets which were not quite finished at the close of the last fiscal year were completed, with the exception of one small group, on July 16, 1900, and the remaining stars were observed during the period February 23 to March 7, 1901.

Observations on the Supplementary List of Comparison Stars for the Planet Eros were commenced by myself and Mr. Littell on December 8, 1900, and were finished on January 29, 1901. Observations of stars with wire screens for personal equation due to star magnitudes, and observations for thread intervals of the new spider-line reticule, furnished by Warner & Swasey in August, were made during October, November, and December, 1900.

A summary of observations made during the year follows:

OBSERVATIONS OF STARS.

Ephemeris stars for clock error	472
Polaris and 43 H Cephei for azimuth of mark	83
Zodiacal stars	307
Comparison stars for Eros	1,370
Thread interval stars	68
Screen stars for personal equation	402
Miscellaneous stars	23
Total number of observations of stars	2,725

DETERMINATIONS OF INSTRUMENTAL CONSTANTS.

Collimation	102
Level (by spirit level)	187
Level (by observations over mercury)	53
Azimuth of meridian mark	83
Azimuth of instrument from mark	347
Nadir point, Circle A	126
Nadir point, Circle B	130
Runs of microscopes	16
Total number of determinations of constants	1,044

The observations with screens for determination of personal equation due to star magnitudes indicate that Mr. Littell's personal equations due to that cause is somewhat larger than my own, and also that small errors exist in the observed times of transit across the separate threads of the reticule, due probably to defects in the illumination of the field.

The pivots of the instrument were investigated in October by means of the hanging level and also with the axial collimator. They were also measured with a spherometer caliper and were found to differ somewhat in size. Their irregularities in form are such as to cause small but appreciable errors in observations in right ascension.

REPAIRS AND ALTERATIONS IN INSTRUMENTS.

A 6½-inch lens of 185 feet focal length by Brashear, together with cast-iron brackets, for south meridian mark, has been furnished during the year by Warner & Swasey, of Cleveland, Ohio, but has not yet been put in place. The north meridian mark has been used during the year with some difficulty as it is not at, but several feet south of the principal focus of the lens through which it is viewed.

The apparatus for illuminating the field of the telescope has been, until recently, so defective as to cause serious error in transit observations. This is apparently due in some way to the fact that the light was reflected obliquely upon the reticule. A part of the original illuminating apparatus was removed and a small circular mirror, which throws the light perpendicularly on the reticule and parallel to the line of collimation, was cemented to the inner surface of the object glass. The illumination of the field is now entirely satisfactory. It is capable of the most delicate adjustment from total darkness to great brilliancy, and all parts of the field are equally bright. This improvement was made without expense to the Observatory.

The two divided circles were sent on April 24 to Warner & Swasey to be redivided, as the old divisions were unsatisfactory. These circles have not yet been returned.

The objectives of the microscopes used in reading the divided circles gave bad definition and on inspection were found to be visibly defective. New objectives have been furnished by Mr. J. A. Brashear.

The collimation and level constants of the instrument change very slowly and continue to be entirely satisfactory, but the large variation of azimuth with temperature mentioned in last year's report has been only partially removed. After various experiments, which gave only negative results, the heavy cast-steel bed-plates were reversed in position by turning each one horizontally on its own pier through 180°. The change of azimuth was then very much reduced in amount. These bed-plates were replaced on June 17 with new cast-iron bed-plates. The tests subsequently made indicate that the amount per degree of the variation of the azimuth with temperature is considerably reduced. The curve of azimuth change is simplified, and the response to changes of temperature is much slower, indicating probably that the remaining trouble lies in the massive marble piers or the manner in which they rest on their foundations. Each pier is supported on three pieces of cardboard about one-fourth of an inch thick. I recommend that the marble piers be replaced by piers built of brick laid in cement in accordance with the best modern practice.

THE CLOCK VAULT.

During January and February a clock vault, 8 feet square and 7 feet high, was built in the basement of the observer's room adjacent to the building which shelters the 6-inch transit circle. The construction of the vault is intended to be such that it will be practicable to keep the temperature within very nearly constant throughout the year. A 9-inch brick wall incloses a wooden house of dimensions above stated, with an air space of 1 foot, which contains hot-water pipes for heating. The whole is roofed over with boards inclosing a 6-inch layer of asbestus wool. The vault contains three brick piers for clocks and one small pier which may be used in mounting a pendulum apparatus for testing the minor irregularities of clock rates. Triple doors are provided and means for slow ventilation.

The location is on the summit of a hill, and drainage conditions are such that the basement in which the vault is situated is remarkably dry. There is little reason to fear damage from rust to the mechanism of the clocks, provided that ordinary care is exercised, even when the clocks are not protected by air-tight cases.

A clock by Kessels, which seems to be in excellent condition, has been mounted in the vault, inclosed in a heavy copper case which has been in the Observatory for some years and out of use. This case has been to some extent remodeled by the Instrument Maker, but all attempts to make it air-tight have been only partially successful. An air-tight case for the Howard clock, No. 404, is now being constructed by Mr. G. N. Saegmuller of Washington.

Very respectfully,

MILTON UPDEGRAFF,
Professor of Mathematics, U. S. N.

The SUPERINTENDENT, NAVAL OBSERVATORY.

THE 12-INCH EQUATORIAL.

SIR: I have the honor to submit the following report of work upon the 12-inch equatorial during the fiscal year ending June 30, 1901. The instrument was placed under my direction March 30, 1901. Prior to that time it was under the general charge of Professor S. J. Brown, U. S. N. It was dismounted in November, 1900, and a number of material changes in the clamps and tangent screws and in the head casting were effected by Mr. G. N. Saegmüller, the original maker of the instrument. These alterations were not entirely completed and the telescope ready for use until the latter part of April, although it had been used occasionally during March and April to give visitors a view of objects which could be picked up without the aid of the circles. The alterations have materially improved its efficiency, but there are still some minor changes possible which would greatly increase the ease of manipulation.

The constants of the instrument have been partly redetermined and a few observations undertaken of faint stars and double stars within the limits of the zone which was observed on the 9-inch transit circle for the Astronomische Gesellschaft. These are not yet completed. The double stars have been measured by Computer E. A. Boeger. Computer G. K. Lawton made one observation of Proserpina ㉖ on June 18, but completed the series on the 26-inch equatorial.

Very respectfully,

THEO I. KING,
In charge 12-inch Equatorial.

The SUPERINTENDENT, NAVAL OBSERVATORY.

THE PRIME VERTICAL TRANSIT AND THE 5-INCH ALT-AZIMUTH.

SIR: In compliance with paragraph 23 of the regulations governing the United States Naval Observatory, I respectfully submit the following report of the operations in my department during the year ending June 30, 1901.

Before proceeding to report upon the observations secured with the instruments I desire to invite the attention of the superintendent to the following extract from Science for January 11, 1901, page 42:

> We find, also, that the total number of separate observations with the prime vertical transit was 164, less than one-half the number of nights in the year, while those with the alt-azimuth, used as a zenith telescope, numbered a little more than the days in the year. At the international geodetic stations the observers are expected to make about 16 double observations on every clear night.

Attention is also invited to this extract from the same publication, but of date January 4, 1901, page 4:

> There are also intimations that something is wrong with the prime vertical transit, and altogether the impression made on the reader is that, after seven years of effort to equip the Observatory with the best instruments, it is doubtful whether a single one of real importance, except the great telescope, is in order for first-class work.

The writer of these editorials in Science clearly indicates that his conceptions of the amount of astronomical observing to be obtained with an instrument in the prime vertical are absurd.

Taking up the first extract, I wish to answer it. I was, by orders of the Department, as well as by yourself, detailed last spring as an observer in one of the parties sent south to observe the eclipse of the sun, and for six weeks I was detached from the instrument.

From April 15 to May 1 I was directed to give my whole time to preparing for shipment the apparatus to be used in the eclipse. From May 1 until June 1, 1900, I was at Griffin and Barnesville, Ga., engaged in preparing for the phenomena just mentioned. In addition, I observed at both places on fifteen nights, to determine their latitude and longitude.

The wisdom of the Observatory displayed in having those two fundamental positions determined is well illustrated by the misfortune that came to an observer who went to Africa. He trusted to an approximate latitude and longitude, and found at the instant of the eclipse he was entirely outside of the shadow line.

If the writer of the above extract was only superficially informed of the time necessary to secure a complete observation of a star across the prime vertical, he would not have attempted to make a comparison between the number of observations secured during the same period with the prime vertical and the zenith telescope. It will take about four hours per night to observe sixteen pairs of stars with the zenith telescope, the number usually obtained by those engaged in the variation of latitude work. In the same time it is impossible for anyone using the prime vertical to secure more than four or five, and had the writer consulted an astronomer he would have found that out.

During the past spring I observed practically all night on each night in which the sky was clear, and during an interval of nine or ten hours the largest number of star observations I could possibly obtain was nine or ten.

As an additional answer to this senseless criticism, I would invite the attention of the Superintendent to a comparison of the number of observations made with our instrument with that obtained by the only other astronomer who is now continuously observing with the prime vertical transit.

In 1900 I obtained in ten and one-half months observing 164 observations. The observer at Pulkowa for the full year made 106. Since 1896 I have secured 1,150 observations. In the same time the prime vertical at Pulkowa has yielded 755. This record will be found in Professor Albrecht's report on the variation of latitude for 1900.

The remarks contained in the second extract are equally absurd.

In justice to our prime vertical transit, I desire here to state that it is of a better form, it is built in a more symmetrical manner, and its mounting permits of determining the errors it may have in a more complete manner than any other now in use.

In 1898 I obtained about 125 observations of α Lyrae in the full daylight, as well as in the night. The range between the greatest and least declination for the whole year's work, including every observation made, and the good, fair, and poor seeing that obtained for each, was 1.″44. If four observations are rejected, because they stand out so markedly from the others, made at a time when the seeing was very poor, and so noted in the observing book, the range is reduced to 1.″04.

There is not in existence a meridian circle, vertical circle, or zenith telescope that has been used to observe the same star or pair of stars, *throughout the year*, that has as small a range as this in the declination, or latitude, obtained with it. The probable error of a single observation for this series, including the variation of latitude, is ±0.″16.

The prime vertical transit is in good order, and has been so since my last report.

I have continued observations by reflection over a basin of mercury, so as to keep a constant check upon the level correction. I give herewith the latitude of the instrument, secured from observations made direct and by reflection, upon dates that are within a very few days of each other. There is not a more critical test of the accuracy of the level correction obtained by the aid of a spirit level, as far as prime vertical observations are concerned, than that of comparing direct and reflected determinations.

An examination of these individual latitudes, as well as the mean of each set, clearly indicates that the level tube is a good one, and is free from systematic errors.

	Latitude.					
	Direct observations.			Reflected observations.		
	°	′	″	°	′	″
	+38	55	14.33	+38	55	14.50
			14.96			14.42
			14.76			14.50
			14.80			14.39
			14.67			15.03
			14.47			14.47
			14.62			14.81
			14.24			14.91
			14.65			14.60
			13.90			14.41
			14.56			14.83
			14.63			14.36
			14.43			14.85
			14.07			14.29
Mean	+38	55	14.54	+38	55	14.60

It will be noticed that these means differ by only 0.″06, and together by only 0.″07 from the general mean given below, which has been obtained from nearly 1,600 observations.

During the year I have made an investigation of the form of the two pivots attached to the instrument. I have examined each throughout the length of its bearing surface in the Ys, and the results, which will be printed in the volume containing the observations secured with the instrument, do not indicate that either pivot is out of parallelism with the cube, or that their departure from a true cylinder is of enough magnitude to affect an observation.

In the past year I have made 619 observations with the aid of both instruments. The reductions of the observations, which have all been made by myself, are practically complete to the 1st of January, 1901.

Last fall I made a complete re-discussion of the prime vertical transit observations, basing the derived latitudes upon the star places obtained from the New Catalogue of Fundamental Stars, prepared by Prof. S. Newcomb. After it was finished the results were transmitted to Professor Albrecht, of the Central Bureau der Internationalen Erdmessung, Potsdam, Germany, to be used by him in his annual paper upon the "Variation of Latitude."

From that discussion the following mean yearly latitudes were obtained:

	°	′	″
1894	38	55	14.51
1895			.52
1896			.61
1897			.46
1898			.45
1899			.43
1900			.55
Mean	38	55	14.50
Reduction to the clock room			—.52
Latitude of Naval Observatory	38	55	13.98

The individual observations of all prime vertical transits up to December 31, 1899, are now ready for the printer. The introduction to the volume to contain them is three-fourths completed, and will be finished in time to transmit it to the Government Printing Office by the last of July or middle of August.

The 5-inch alt-azimuth was used during the year principally as a zenith telescope, in connection with the prime vertical transit. I am not making zenith-telescope observations exclusively with it, but only of those stars that are observed with the prime vertical, and which permit of being observed by Talcott's method.

This Observatory is the only one in this country equipped with a prime vertical transit, and for that very reason the major portion of the data we are securing for the study of the variation of latitude is made with it.

To keep a constant check upon the results of the first-mentioned instrument, to be able at all times to compare its working with the zenith telescope, has been the constant aim of this Observatory, and a comparison of observations for latitude from two methods of observing so unlike as obtains in these two instruments is bound to reveal any systematic errors existing in either, when quantities as small as those causing the change of latitude are to be measured.

I would respectfully bring to the attention of the Superintendent the need in this department of a computer employed at a moderate compensation. In addition to my observing, in the past all the reductions of observations secured from both instruments have been made by myself. This year I find I am falling in arrears. Such an assistant would relieve me of a great deal of routine copying and computing, and permit me to investigate other problems in my work that demand attention, but which have not been taken up for want of time.

I would also invite his attention to the need of a mark for the prime vertical transit. One of the criticisms that has been made of the instrument is the absence of such a mark. This is a fair criticism, for the observer should at all times be able to determine the azimuth of the instrument, especially between the east and west transits of a star. Professor Hall in my presence suggested the necessity of it, and Professor Harkness had promised that before he retired he would mount the mark, but many other pressing needs came in and he left the Observatory before he was able to do so.

Respectfully submitted.

Geo. A. Hill,
Assistant Astronomer.

The Superintendent, Naval Observatory.

THE 40-FOOT PHOTOHELIOGRAPH.

Sir: During the year photographs were made of the sun on 116 days. Sun spots were observed on them on 24 days, as follows: October, 13 days; November, 1 day; February, 5 days; May, 3 days.

This shows a very quiescent state of solar activity, the average number of spots being slightly less than the year preceding. Besides sun spots, the plates show many faculæ and fine detail in the granulation of the solar surface. This was rendered possible by the use of photographic plates, having a fine-grained lantern-slide emulsion, giving contrast and fine definition by the use of special developer.

Owing to my absence on duty with the Naval Observatory eclipse expedition to Sumatra, the daily record was kept by Computer E. A. Boeger from February 8 to the end of the fiscal year.

Respectfully,
Geo. H. Peters,
Photographer in Charge.

The Superintendent, Naval Observatory.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

Sir: The appropriation for the observation of this eclipse became available early in January, 1901, thus affording very scant time for preparations, which were necessarily pushed to completion previous to February 1, when it was necessary to ship the instruments.

The expedition comprised the following persons:

Prof. A. N. Skinner, U. S. N., chief.
Prof. W. S. Eichelberger, U. S. N.
Assistant Astronomer F. B. Littell.
Photographer G. H. Peters.
Assistant L. E. Jewell.

Assistant W. W. Dinwiddie.

In addition to the above members of the Naval Observatory staff the following scientists were invited to become members of the expedition:

Prof. E. E. Barnard, Yerkes Observatory.
Dr. W. J. Humphreys, University of Virginia.
Dr. N. E. Gilbert, Johns Hopkins University.
Dr. S. A. Mitchell, Columbia University.
Mr. H. D. Curtis, University of Virginia.

The place of observation selected was the west coast of Sumatra, in the vicinity of Padang. Arrangements were made for the transportation of the expedition from San Francisco to Manila on an army transport and from Manila to Padang, Sumatra, on a United States war vessel to be designated by the commander in chief of the Asiatic Station.

The instruments were shipped by fast freight to San Francisco January 26, where they arrived February 13. The eclipse party left Washington February 5 to 7 and arrived in San Francisco February 10 to 12. The instruments having been placed on board, the expedition sailed on the U. S. army transport *Sheridan* February 16. The *Sheridan* arrived at Honolulu February 25; sailed from Honolulu February 28 and arrived at Manila March 18, after a prosperous and uneventful voyage.

Admiral Remey, commander in chief of the Asiatic Station, designated the U. S. S. *General Alava*, Lieutenant-Commander Halsey commanding, to convey the expedition from Manila to Padang, Sumatra. The equipment having been transferred from the *Sheridan* to the *General Alava*, the expedition sailed from Manila March 26, proceeded direct through the Straits of Sunda and arrived at Emma Haven, the port of Padang, 7 kilometers distant, on April 4. The eclipse party was first greeted by the United States consular agent, Cornelius G. Veth, who rendered invaluable assistance in placing the party in communication with the officials of the Netherlands Government. Aid was freely granted in numberless ways by Governor Joekes and his subordinates thoughout the island. It should be specially noted that free transportation was granted over the entire railway system for the members of the expedition and for the instrumental outfit, weighing about 15 tons.

The three stations for observation selected by Professor Skinner were Fort de Kock, situated near the northern edge of the shadow, Solok and Sawah Loento, two points where the railroad in the interior runs nearest the central line of the shadow. The distances of these stations by rail from Emma Haven are, respectively, Fort de Kock, 94 kilometers; Solok, 128 kilometers; and Sawah Loento, 156 kilometers.

At the request of Professor Skinner the expedition received valuable assistance from Ensign Gilbert Chase, Cadet W. V. Tomb, U. S. N., and Asst. Surg. H. E. Odell, officers of the *General Alava*. Through the courtesy of Lieutenant-Commander Halsey the expedition was favored with the assistance of eight men from the *General Alava*, viz: A. L. Smith, W. A. Vanaken, R. H. Schops, M. C. Suman, J. J. Few, W. J. Cassidy, C. W. Keeter, and G. H. Getz, who rendered most efficient service, which is worthy of mention.

The expedition received valuable volunteer assistance from Mr. G. E. Irving, agent of the British and Foreign Bible Society, Mr. René Granger, of Cartersville, Ga., and Mr. Melvin Munson, of Padang.

The distribution of the instruments, observers, and assistants was as follows:

FORT DE KOCK STATION.

[In charge of Prof. W. S. EICHELBERGER, U. S. N.]

1. Thirty-foot concave grating spectroscope, in charge of Dr. W. J. Humphreys. This grating is the property of Mr. L. E. Jewell.

2. Photoheliograph of 5 inches aperture and 39 feet focal length, in charge of Photographer G. H. Peters, assisted by A. L. Smith.

These two instruments were fed by a Brashear coelostat, furnished with two 10-inch silver-on-glass mirrors especially built for the Naval Observatory for such work.

SOLOK STATION.

[In charge of Prof. A. N. SKINNER, U. S. N.]

1. Photoheliograph of 6 inches aperture and 61.5 feet focal length, in charge of Prof. E. E. Barnard. This instrument was fed by a coelostat furnished with a silver-on-glass mirror 15 inches in diameter. The objective and coelostat are the property of the Yerkes Observatory.

2. Ten-foot concave grating spectroscope, in charge of Mr. L. E. Jewell, assisted by R. H. Schops.

3. Flat-grating spectroscope used with a slit, in charge of Assistant Astronomer F. B. Littell. This grating is the property of the Johns Hopkins University.

4. Prismatic camera, in charge of Assistant W. W. Dinwiddie. The 60° flint-glass prism has faces about 6 inches square; the telescope employed with it has an object glass 6 inches in aperture and 7.5 feet focal length. The prism and object glass are the property of the Smithsonian Institution.

5. Spectropolarigraph devised and furnished by Prof. R. W. Wood, of Madison, Wis., now of Johns Hopkins University; in charge of Dr. N. E. Gilbert, assisted by J. J. Few.

6. Photoheliograph, 7.5 inches in aperture and 114 inches focal length, in charge of Mr. H. D. Curtis.

7. Voigtlaender doublet, 6.25 inches in aperture and 31 inches focal length.

8. Clark doublet, 3.25 inches in aperture and 30 inches focal length.

Nos. 7 and 8, which are the property of the Yerkes Observatory, were mounted by Mr. H. D. Curtis on a 6-inch equatorial stand loaned by Mr. G. N. Saegmuller. They were placed in charge of Mr. G. E. Irving, assisted by W. J. Cassidy and G. H. Getz.

Instruments 2, 3, 4, and 6 were fed by modified coelostats originally constructed for transit of Venus work.

SAWAH LOENTO STATION.

[In charge of Dr. S. A. MITCHELL.]

1. Flat grating spectroscope in charge of Dr. S. A. Mitchell, assisted by C. W. Keeter.

2. Photoheliograph, 6 inches in aperture and 104 inches in focal length, in charge of Mr. René Granger.

In brief, the results obtained were as follows:

At Fort de Rock, on the day of the eclipse, the sky was perfectly clear, thus permitting Mr. Peters, with the photoheliograph, to secure ten negatives, and Dr. Humphreys, with the 30-foot concave grating, six photographic spectra. Professor Eichelberger observed the times of the first, second, and third contacts.

At Solok Professor Skinner was able to observe the times of the first, second, and fourth contacts; but clouds, more or less dense, prevented securing photographic negatives of any value.

At Sawah Loento the clouds were somewhat less dense than at Solok. Mr. Granger secured six negatives with the photoheliograph, and Dr. Mitchell six photographic spectra with the flat grating.

An interesting incident of the stay in Solok was the sudden appearance of a naked-eye comet, which was first seen by Mr. W. W. Dinwiddie in the western sky shortly after sundown on May 3. Mr. Curtis and Professor Barnard secured several photographs of the comet May 5 and 6.

It should be especially noted that the utmost generosity was displayed by all the officials of Sumatra in freely affording assistance to the expedition at every opportunity.

After the eclipse the negatives were promptly developed. The equipment was packed, shipped by rail to Emma Haven, and placed in the hold of the *General Alava*, on board of which the expedition sailed for Manila May 28. The *General Alava* touched at Tandjong Priok, the port of Batavia, May 31, sailed therefrom June 1, and arrived at Manila June 8.

By authority of Admiral Rodgers, at Manila, the instruments were transferred to the U. S. S. *Culgoa* and shipped to the United States via Suez.

Transportation for Messrs. Gilbert and Humphreys was furnished from Manila to San Francisco on board the U. S. army transport *Meade*, which was billed to sail from Manila July 1. Transportation for the remainder of the party was obtained on board the U. S. chartered transport *Indiana*, which sailed from Manila, after some days' delay, on June 20 and proceeded without stop to San Francisco, where she arrived July 16. From San Francisco the members of the expedition proceeded to their destinations by rail.

Very respectfully,

A. N. Skinner,
Professor of Mathematics, U. S. N.,
In charge Expedition.

The Superintendent, Naval Observatory.

REPORT OF COMPUTING BUREAU.

Sir: I have the honor to submit the following report of computations during the fiscal year ending June 30, 1901. The Computing Bureau was established September 12, 1900, under charge of Professor W. S. Eichelberger; during Professor Eichelberger's trip to Sumatra, beginning February 7, 1901, Assistant Astronomer Theo I. King supplied his place. The force engaged upon the work were Computers W. M. Brown, E. A. Boeger, G. K. Lawton, and J. C. Hammond; Mr. A. B. Turner, July 11 to August 23, 1900; Mr. W. W. Dinwiddie, July 17 to August 31, 1900; Mr. J. A. Lyon, July 18 to August 24, 1900; Misses E. A. Lamson and C. M. Upton, from July 21, 1900; Mr. Roy Y. Ferner, from August 2, 1900; Mr. E. I. Yowell, from February 6, 1901; Mr. H. R. Morgan, from March 26, 1901; Mr. C. W. Frederick, from April 2, 1901; and Miss C. C. Barnum, from April 4, 1901.

During the year Volume I, Second Series, "Publications of the United States Naval Observatory, Sun, Moon, Planets, and Miscellaneous Stars, 1894–1899," has been completed and published. The reduction of subsequent observations is also practically up to date. The Zone, −13° 50′ to −18° 10′, is designed to constitute Volumes II and III. For this the printer's copy, covering the observations to 1900, is completed. The remaining observations already made are reduced, and the issue of the two volumes is confidently looked for before the close of the year 1901.

In accordance with the statements in the introduction of Volume I, and on page 24 in the "Report of the Superintendent for the year ending June 30, 1900," the volumes of the new series will be classified, and each one will contain only the material pertaining to its title. The observations of Eros and comparison stars made during the past twelve months should make Volume IV. This material has been completely reduced, and is ready for the printer.

Considerable progress has been made in reducing the observations of Zodiacal stars by Professor Eichelberger.

The order creating the computing bureau reads as follows:

> Bureau of Reductions.—A computing bureau is established, under charge of Professor Eichelberger, to which all computers are assigned, and they shall report to the officer in charge of that bureau, except when especially assigned to other duties. The object of this bureau is to relieve the individual observer from routine reductions, thus giving him time while not observing for the discussion of his instrument and the results of his observations. Whenever pieces of computing are available on any of the instruments, they will be reported to the Astronomical Director for consignment to this bureau.

The bureau has established its utility, and I would recommend the enlargement of this order to include the custody of all observations, records, and computations. I think a place for this matter should be provided, adapted for its preservation and for rendering it easily accessible.

Very respectfully,

Theo I. King,
In charge Computing Bureau.

The Superintendent, Naval Observatory.

REPORT OF THE DIRECTOR OF THE NAUTICAL ALMANAC.

United States Naval Observatory,
Nautical Almanac Office,
Washington, D. C., August 31, 1901.

Sir: I have the honor to submit the following report of the operations of the Nautical Almanac Office for the fiscal year ending June 30, 1901:

PRINTING.

The books published during the year were received from the Government Printing Office on the following dates:

The Pacific Coaster's Nautical Almanac for 1901, first edition, October 2, 1900;

The American Ephemeris and Nautical Almanac for 1901, second edition, December 22, 1900;

The American Nautical Almanac for 1901, third edition, February 8, 1901;

The American Nautical Almanac for 1904, first edition, March 15, 1901;

The American Ephemeris and Nautical Almanac for 1904, first edition, April 20, 1901;

The American Nautical Almanac for 1902, second edition, May 22, 1901.

DISTRIBUTION OF PUBLICATIONS.

During the fiscal year ending June 30, 1901, the sale and distribution of publications were as follows:

Title.	Sold.	Distributed.	Bureau of equipment.	Public service.	Total.
American Ephemeris	963	249	60	562	1,834
American Nautical Almanac	3,251	24	33	326	3,634
Pacific Coaster's Nautical Almanac	1,826	0	10	14	1,850
Astronomical Papers	106	48	1	44	199

The proceeds of the above sales amounted to $2,379.48, and, in compliance with law, that money has been deposited to the credit of the Treasurer of the United States on account of public printing and binding.

THE AMERICAN EPHEMERIS.

While the law authorizing the publication of the American Ephemeris provides for the issue of each volume three years in advance of its date, yet that for 1904 was issued the latter part of April, 1901, or nearly four months late. A systematic redistribution of the office force, while not interfering with the new investigation now in progress, will prevent this delay in the future.

The general arrangement and plan of the Ephemeris, with a few minor changes, remain the same as in the volume for 1904. Struve and Peter's constants have been used in the main body of the work to secure uniformity with preceding volumes. The data which can not be thoroughly checked by differences has been computed in duplicate.

NEW INVESTIGATIONS.

The wide divergence between observations and tabular places from Damoiseau's tables has shown the desirableness of forming new tables of Jupiter's satellites. This work, which it is hoped may be finished in five or six years, has been commenced and will be pushed as rapidly as the regular work on the Ephemeris will permit.

The work of determining new elements of the inner satellite of Uranus has been completed.

The catalogue of Zodiacal stars prepared for use in this office in computing occultations, is so far advanced that the data contained in this catalogue are available for use in computing the occultations for 1905.

MISCELLANEOUS.

Through the courtesy of the Superintendent of the Naval Observatory, facilities have been furnished to refit the library and permit of the proper classification of the volumes.

A card-index system for cataloguing the library and briefing the correspondence has been installed.

More than 30,000 volumes of the publications of this office, which have lain in the basement for years, have been securely tied in packages and placed upon shelves.

The original computations of the Astronomical Papers will be placed in the library, classified, and properly indexed.

I desire to invite attention to the efficiency of the assistants in this office, who are, without exception, graduates of leading universities of America and Europe, and I do not consider it inappropriate to say that their salaries are entirely inadequate to the duties required of them.

Very respectfully,

Walter S. Harshman,
Professor of Mathematics, U. S. N.,
Director Nautical Almanac.

The Superintendent, Naval Observatory.

DEPARTMENTS OF NAUTICAL INSTRUMENTS AND OF GENERAL STOREKEEPER.

Sir: The preparation of requisitions for the purchase of instruments, supplies, etc., and for necessary repairs to old instruments, for issue to ships, navy-yards, and naval stations, has been continued in the Department of General Storekeeper.

The following table shows the number of instruments and articles purchased, and the number issued in the regular routine business for the fiscal year ending June 30, 1901:

Stores received and issued by General Storekeeper's Department.

Instruments, supplies, etc.	Received.	Issued.
Artificial horizons	0	22
Sextants:		
High-grade	19	36
Squadron angles	0	7
Hydrographic	168	133
Spare glass for	0	68
Octants	9	36
Parallel rulers:		
Sigsbee	0	3
Ordinary	125	65
Clocks:		
Deck	30	58
No. 2	83	51
Boat	112	95
Protractors, three-arm	60	69
Drawing instruments, boxes	39	67
Dividers, navigator's	47	44
Tapes, steel	39	23

Stores received and issued by General Storekeeper's Department—Continued.

Instruments, supplies, etc.	Received.	Issued.
Thermometers:		
Maximum and minimum	72	0
Air and water	226	365
Psychrometers	25	27
Spyglasses:		
Low-power	68	48
Medium-power	19	32
High-power	62	57
Officer of deck	145	52
Binoculars:		
Day	263	135
Night	227	153
Barometers, aneroid	66	54
Clinometers, Hicks	0	16
Reading glass, captain's	38	35
Splines and weights	49	22
T-squares	19	3
Magnetometers	2	2
Dip circles	2	2
Transit, surveyor's	0	13
Theodolites	8	20
Patent star finder	1	0
Course indicator	1	0
Barograph	1	1

The aggregate value of instruments and stores purchased, not including those received from navy-yards and other sources, amounted to $49,100.93 during the year.

The number of regular shipments during the year was 168, and the invoiced value amounted to $43,864.46.

Shipment has been made of the 6 complete outfits for hydrographic survey in the Philippine Islands, of the 4 additional outfits for hydrographic work, and of the 2 outfits for the telegraphic determination of longitude assembled during the previous year.

In addition to the above ordinary work the assembling and inspection of 4 more survey outfits and 2 more outfits for telegraphic determination of longitude have been almost completed during the year. One of the longitude outfits has been shipped.

The value of a survey outfit is $3,450.82, approximately, and the value of a longitude outfit is $3,658.60, approximately, giving a total for the 18 outfits of $62,945.88. All the outfits have been purchased under the appropriation "Ocean and Lake Surveys."

As will be easily seen this additional work has been considerable, and the department has suffered no little inconvenience by the temporary detachment of the officer in charge.

M. E. Porter, *Computer*.

The Superintendent, Naval Observatory.

DEPARTMENT OF CHRONOMETERS AND TIME SERVICE.

Sir: During the year 14 standards and 4 hacks, which were purchased with ships during the Spanish war, have been reported to the Observatory. One hack which was captured has been repaired and is now ready for issue. A competitive trial for the purchase of new chronometers was held. Seventeen chronometers were entered, and of these 9 were purchased.

The following table shows the present location of all the seagoing chronometers belonging to the Navy:

	In service afloat.	At Mare Island.	At shore stations.	Ready for issue.	Undergoing repairs.	Total.
M. T. standards	2650	14	15	32	28	354
M. T. hacks	8	7	19	2	3	111
M. T. break circuits	2	0	6	0	1	9
Sid. break circuits	6	1	4	1	3	15
Sid. standards	0	1	0	1	0	2
Thermometric	0	0	0	2	2	4
Pocket	0	0	0	5	1	6
Total	353	23	44	43	38	501

The following table includes the chronometers at Mare Island, Cal., in addition to the same for the Observatory, and shows the number received and issued during the year:

	Purchased.		Returned from—			Condemned to be hacks.	Converted from standards.	Issued to—			Condemned to be hacks.	Converted from standards.
	New.	With ships.	Ships.	Shore stations.	Makers.			Ships.	Shore stations.	Makers.		
M. T. standards	9	14	38	6	40	0	0	84	1	36	5	1
M. T. hacks	0	5	11	0	7	5	0	25	0	6	0	0
M. T. break circuits	0	0	0	1	0	0	1	1	1	1	0	0
Sid. break circuits	0	0	1	3	4	0	0	4	2	3	0	0

On August 14, 1900, a requisition was made for the purchase of 12 standard chronometers after a competitive trial, and notice was sent to the principal firms of chronometer makers in the United States.

Three firms entered chronometers in the competitive trial. Wm. Bond & Son entered 8, C. A. Geissler entered 6, and T. S. & J. D. Negus entered 3.

One chronometer, Bond 563, passed trial with a trial number of 8.3, and was purchased, according to specifications, for $350. Four chronometers—Bond 566 and 552, and Negus 1875 and 1884—passed with trial numbers between 9 and 16. These were purchased at $330 each. Four chronometers—Geissler 1061, Bond 555 and 562, and Negus 1905—had trial numbers between 16 and 25. These were purchased, with the consent of the Bureau of Equipment, at $300 each.

Twenty of the Bureau's chronometers were subjected to the same trial for the determination of new rate curves.

The temperature trial began January 4 and ended March 30. The chronometers were then placed in the chronometer room and run for twelve weeks.

The apparatus for regulating the temperature operated satisfactorily. The following table shows the detail results of the trial:

Relative number.	Time			Dec. 28 to Jan. 4.	Jan. 7 to Jan. 14.	Jan. 18 to Jan. 25.	Jan. 29 to Feb. 5.	Feb. 7 to Feb. 14.	Feb. 21 to Feb. 28.	Mar. 2 to Mar. 9.	Mar. 12 to Mar. 19.	Mar. 23 to Mar. 30.	Apr. 4 to Apr. 11.	Apr. 11 to Apr. 18.	Apr. 18 to Apr. 25
	Temperature, Fahrenheit ....degrees..			90.0	85.0	69.8	54.9	45.7	55.0	69.7	85.1	90.0	66.6	66.0	70.4
	Relative humidity..................per cent..			69	68	71	66	72	70	70	71	68	58	64	58
	Repaired by—	Chronometer No.	Maker.												
1	Bliss	3668	T. B. Winter & Son	+1.30	+0.64	+0.61	+0.33	+0.57	+1.00	+0.96	+0.99	+0.51	−0.19	−0.21	−0.06
2	Negus	1298	T. S. & J. D. Negus	+2.24	+1.19	+0.66	+1.33	+2.76	+1.23	+0.43	+1.26	+1.86	+0.81	+0.99	+0.63
3	Heinrich	1021	H. H. Heinrich	+1.96	+1.53	+0.47	+0.21	+0.46	+0.39	+0.39	+1.53	+1.94	+0.81	+0.70	+0.89
4	Bond	2087	Dent	+5.13	+4.04	+2.89	+3.14	+4.29	+3.46	+3.29	+4.23	+4.56	+2.43	+2.51	+2.60
5	Negus	1343	T. S. & J. D. Negus	+0.99	+0.54	−0.56	−0.43	+0.69	−0.27	−0.70	+0.13	+0.61	−1.26	−1.33	−1.59
6	....do	1595	....do	+1.99	+1.70	+0.90	+1.67	+3.07	+1.79	+1.03	+1.83	+2.40	+1.29	+1.30	+1.03
7	....do	1234	....do	+1.33	+1.44	+0.47	+0.86	+1.90	+0.64	+0.13	+1.20	+1.96	+0.53	+0.37	+0.34
8	....do	1777	....do	+2.37	+2.84	+1.87	+1.90	+2.66	+1.94	+2.10	+3.36	+3.69	+2.74	+2.70	+2.89
9	....do	1305	....do	+2.70	+2.90	+2.06	+2.79	+3.71	+2.39	+1.54	+2.46	+3.34	+2.24	+2.21	+1.94
10	Bliss	454	Hutton	+0.63	+0.14	−0.10	+0.89	+2.11	+0.91	−0.03	+0.39	+0.73	+0.86	−0.20	+1.10
11	Bond	49457	Dent	−1.34	−1.51	−0.99	−0.11	+0.61	+0.26	−0.29	−0.84	−1.76	−0.11	+0.06	+0.26
12	Bliss	2149	John Bliss & Co.	+0.56	−0.07	−0.94	+0.19	+1.60	+0.29	−0.63	+0.09	+0.36	+0.76	+0.13	+0.44
13	Negus	1300	T. S. & J. D. Negus	+2.37	+2.14	+1.80	+3.33	+4.80	+3.36	+2.07	+1.81	+2.59	+1.74	+2.23	+1.56
14	Bond	549	Wm. Bond & Son	+0.46	+1.04	+0.80	+1.64	+2.69	+1.79	+0.96	+1.77	+2.16	+0.57	+0.51	−0.01
15	Negus	1464	T. S. & J. D. Negus	+2.13	+2.61	+1.63	+2.23	+3.58	+1.71	+0.70	+1.59	+2.33	+1.80	+1.70	+1.53
16	....do	1120	....do	+3.17	+2.23	+1.29	+1.79	+3.07	+1.34	+0.50	+0.77	+1.51	+1.13	+1.06	+0.80
17	....do	997	....do	−0.01	+0.10	−0.39	+0.93	+2.33	+0.83	−0.61	−0.27	+0.26	+0.27	+0.54	−0.23
18	Bliss	2803	John Bliss & Co	−0.87	−1.31	−1.70	−0.36	+1.14	−0.70	−2.46	−2.27	−1.89	−2.41	−2.97	−3.44
19	....do	7364	Roberts	+0.49	−0.24	−2.17	−0.67	−0.57	−1.54	−2.21	−0.69	+0.33	−0.99	−1.00	−1.49
20	Bond	295	Wm. Bond & Son	+3.91	+3.90	+1.80	+0.86	+0.96	+0.21	+1.00	+3.54	+5.73	+3.36	+3.13	+3.34
1		563	Wm. Bond & Son	+0.87	+0.33	−0.33	−0.29	+0.13	−0.07	−0.54	+0.09	+0.46	−0.83	−0.83	−0.94
2		566	....do	+2.63	+2.71	+2.64	+3.09	+3.87	+3.13	+2.04	+2.34	+3.27	+1.89	+1.99	+1.81
3		1875	T. S. & J. D. Negus	+0.37	+0.33	−0.17	+0.59	+1.83	+0.60	−0.16	+0.44	+0.80	+0.11	+0.11	−0.11
4		552	Wm. Bond & Son	+2.14	+1.83	+0.79	+0.26	+0.83	+0.49	+0.46	+1.87	+2.61	+0.27	+0.09	+0.31
5		1884	T. S. & J. D. Negus	+3.17	+2.76	+1.94	+2.07	+3.26	+2.10	+1.63	+2.59	+3.36	+1.31	+1.60	+0.91
6		1061	C. A. Geissler	+0.87	+0.41	−0.63	−0.39	+0.70	−0.29	−1.04	+0.19	+0.89	−0.99	−0.94	−1.11
7		555	Wm. Bond & Son	+3.06	+3.19	+2.21	+1.83	+2.57	+1.86	+1.89	+3.34	+4.23	+1.34	+1.23	+1.31
8		562	....do	−1.33	−1.59	−1.33	+0.24	+2.50	+0.43	−1.43	−1.63	−1.27	−0.97	−0.90	−1.23
9		1906	T. S. & J. D. Negus	+2.58	+2.50	+1.37	+1.83	+2.83	+1.66	+0.84	+1.44	+2.01	+0.60	+0.44	+0.24
10		1059	C. A. Geissler	−0.69	−0.93	−2.01	−2.29	−1.97	−2.71	−2.51	−1.40	−1.86	−2.07	−2.29	−2.27
11		1049	H. H. Heinrich	+1.56	+1.11	+0.51	−0.14	+2.19	+0.60	+0.27	+1.26	+1.66	−0.34	−0.94	−0.40
12		1047	....do	−1.57	−1.00	−1.91	−1.50	+1.07	−1.76	−2.76	−1.53	−0.87	−1.30	−1.23	−1.76
13		1048	....do	+2.80	+3.29	+2.17	+3.26	+3.96	+1.86	+2.21	+3.50	+3.80	+2.16	+1.77	+1.17
14		511	Wm. Bond & Son	+1.94	+2.44	+1.89	+1.71	+5.09	+2.36	+1.24	+1.94	+2.73	−0.30	−0.49	−0.69
15		559	....do	−0.14	−0.67	−1.79	+0.39	+1.91	+0.06	−1.54	−1.31	−1.00	−0.39	−0.81	−1.61
16		565	....do	+0.91	+1.57	+0.64	−0.50	−0.29	−0.69	−0.11	+0.76	+0.73	+0.07	+0.14	+0.21
17		1046	H. H. Heinrich	+1 17	+0.86	+1.50	+3.41	+5.54	+3.84	+1.41	+2.53	+2.04	+0.13	+1.06	+1.17

Relative number.	Repaired by—	Chronometer No.	Maker.	Time									Temperature of compensation.	Temperature constant.	Trial number.
			Time	Apr. 25 to May 2.	May 2 to May 9.	May 9 to May 16.	May 16 to May 23.	May 23 to May 30.	May 30 to June 6.	June 6 to June 13.	June 13 to June 20.	June 20 to June 27.			
			Temperature, Fahrenheit ....degrees..	72.3	69.9	67.3	67.2	67.2	66.7	70.4	74.0	75.2			
			Relative humidity..................per cent..	52	55	64	66	70	67	72	74	75			
1	Bliss	3668	T. B. Winter & Son	0.00	−0.23	−0.41	−0.33	−0.77	−0.53	−0.33	−0.16	+0.03	84.7	−0.00018	9.3
2	Negus	1298	T. S. & J. D. Negus										70.3	+0.00316	13.7
3	Heinrich	1021	H. H. Heinrich	+1.03	+0.56	+0.59	+0.64	+0.30	+0.31	+0.50	+0.23	+0.53	60.3	+0.00209	14.2
4	Bond	2087	Dent	+2.79	+2.59	+2.44	+2.64	+2.36	+2.54	+2.76	+2.76	+2.96	65.0	+0.00273	14.7
5	Negus	1343	T. S. & J. D. Negus	−1.33	−1.56	−1.56	−1.53	−1.64	−1.53	−1.24	−1.24	−0.90	65.8	+0.00278	15.0
6	do	1595	do	+1.21	+1.04	+0.99	+0.93	+0.66	+0.74				69.9	+0.00347	15.3
7	do	1234	do	+0.39	+0.30	+0.13	+0.14	+0.01	+0.00	0.00	+0.01	+0.13	67.1	+0.00323	16.5
8	do	1777	do	+3.07	+3.01	+2.69	+2.54	+2.33	+2.33	+2.67	+2.80	+3.03	61.5	+0.00232	22.5
9	do	1305	do	+1.91	+1.96	+1.73	+1.64	+1.50	+1.44	+1.43	+1.47	+1.50	69.6	+0.00371	22.8
10	Bliss	454	Hutton	+0.06	−0.26	−0.31	−0.17	−0.36	−0.24	−0.27	−0.36	−0.11	73.7	+0.00287	23.5
11	Bond	49457	Dent	+0.20	−0.19	−0.56	−0.71	−1.07	−1.24	−1.03	−1.39	−1.43	127.3	+0.00037	24.1
12	Bliss	2149	John Bliss & Co	+0.63	+0.51								71.0	+0.00400	24.4
13	Negus	1300	T. S. & J. D. Negus	+1.00	+1.36	+0.97	+0.93	+0.86	+0.74	+0.76	+0.91	+0.99	77.0	+0.00324	25.3
14	Bond	549	Wm. Bond & Son	+0.06	+0.24	−0.13	−0.29	−0.39	+0.21	+0.21	−0.06	+0.47	71.7	+0.00305	29.5
15	Negus	1464	T. S. & J. D. Negus	+1.41	+1.36	+1.33	+1.36	+1.21	+1.20	+1.20	−1.13	+1.29	69.5	+0.00385	34.9
16	do	1120	do										70.3	+0.00282	40.0
17	do	997	do										73.9	+0.00405	40.2
18	Bliss	2803	John Bliss & Co	−3.80	−3.83	−3.60	−3.24	−3.14	−3.10	−3.36	−3.37	−3.37	75.1	+0.00412	44.9
19	do	7364	Roberts	−1.51	−1.61	−1.81	−1.96	−2.20	−2.24	−2.30	−2.30	−2.16	68.3	+0.00625	55.7
20	Bond	295	Wm. Bond & Son	+3.13	+2.89	+2.59	+1.50	+1.36	+1.27	+1.20	+1.16	+0.96	53.2	+0.00316	70.8
1		563	Wm. Bond & Son	−0.93	−1.13	−1.13	−1.14	−1.21	−1.10	−0.79	−0.63	−0.47	66.8	+0.00200	8.4
2		566	do	+1.81	+1.77	+1.84	+1.69	+1.64	+1.80	+1.64	+1.51	+1.56	74.8	+0.00210	13.2
3		1875	T. S. & J. D. Negus	−0.09	−0.11	−0.13	−0.14	−0.57	−0.59	−0.44	−0.61	−0.49	71.3	+0.00288	13.5
4		552	Wm. Bond & Son	+0.41	+0.39	+0.47	+0.47	+0.36	+0.40	+0.47	+0.47	+0.79	58.7	+0.00219	13.5
5		1884	T. S. & J. D. Negus	+1.20	+1.17	+1.04	+1.19	+1.23	+1.31	+1.43	+1.44	+1.47	66.3	+0.00260	15.5
6		1061	C. A. Geissler	−1.09	−1.26	−1.24	−1.24	−1.29	−1.24	−1.24	−1.31	−1.11	67.1	+0.00359	17.3
7		555	Wm. Bond & Son	+1.33	+1.24	+1.19	+1.19	+0.93	+0.87	+1.03	+1.01	+1.17	59.1	+0.00215	17.4
8		562	do	−1.44	−1.33	−1.24	−1.17	−1.14	−1.03	−1.27	−1.31	−1.30	79.6	+0.00338	22.0
9		1906	T. S. & J. D. Negus	+0.24	+0.13	+0.16	+0.21	+0.01	+0.14	+0.19	+0.21	+0.40	68.9	+0.00353	25.0
10		1059	C. A. Geissler	−2.73	−2.83	−3.10	−3.03	−2.64	−3.59	−2.97	−2.99	−2.94	58.1	+0.00189	35.2
11		1049	H. H. Heinrich	−0.59	−0.83	−1.30	−1.26	−0.10	+0.23	+0.53	+0.70	+0.81	58.5	+0.00139	42.5
12		1047	do	−2.16	−2.11	−2.24	−2.17	−2.21	−2.06	−2.26	−2.30	−2.16	68.5	+0.00393	44.6
13		1048	do	+1.93	+1.66	+1.69	+1.69	+1.26	+1.57	+1.04	+1.23	+1.41	66.0	+0.00347	45.3
14		511	Wm. Bond & Son	−1.16	−1.40	−1.66	−1.47	−1.41	−0.90	−0.49	+0.11	+0.41	68.9	+0.00244	49.6
15		559	do	−1.66	−1.69	−1.87	−1.97	−2.00	−2.10	−2.41	−2.57	−2.67	73.5	+0.00572	58.3
16		565	do	+0.37	+0.31	+0.06	−0.11	−0.71	−0.81	−0.50	−0.63	−0.40	722.5		71.6
17		1046	H. H. Heinrich	+0.84	+1.10	+1.33	+1.19	+1.43	+1.90	+2.47	+2.59	+2.03	75.9	+0.00540	91.4

WATCHES.

The following table shows the number of watches issued and received:

	Issued.	Purchased.	Returned.	Repaired.	On hand.	Held for repairs.
Comparing	27	19	7	25	40	2
Stop	44	67	8	9	39	6
Torpedo boat	3	1	0	1	0	0

THERMOMETERS.

During the year 37 maximum and minimum thermometers have been issued, and 48 are now ready for issue. Four have been returned from ships.

THE TIME SERVICE.

During the year 142 observations for time were made. The 3 standard clocks and the 2 clocks for transmitting noon signals have performed fairly well. Noon signals were sent out every day in the year except Sundays. The average error for the year of noon signals (seventy-fifth meridian time) was 0.13 seconds.

Very respectfully,

M. E. Porter, *Computer*.

The Superintendent, Naval Observatory.

MAGNETIC DEPARTMENT.

Sir: I have the honor to submit the following report of operations in the Magnetic Department during the fiscal year ending June 30, 1901. No effort has been made to obtain magnetic records, because the disturbances occasioned by the grounding of electric traction and light wires still exist. The plant has been twice inspected during the year, and is in good order. The clocks are regularly wound.

Very respectfully,

Theo I. King,
In charge Magnetic Department.

The Superintendent, Naval Observatory.

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B.